**Teacher Handout:**

**Curriculum Expectations:**

E2.3 predict the ability of different materials to hold or transfer electric charges (i.e., to act as insulators or conductors), and test their predictions through inquiry

**Learning Goals:**

1. Students will be learning to build simple series circuits  
2. Student will explore connection between voltage and current   
3. Students will investigate and inquire concepts behind batteries and circuits

4. Students will learn about flow of current within a circuit (anode to cathode)

5. Students will learn about the conductivity of electrolyte (citric acid)

**Activity Background:**

The lemon battery may not be able to light a bulb or LED light but to see that there is electrical current passing through it the voltage of the circuit can be measured and this shows that in fact there is current passing through the circuit. Students learn the scientific method and are able to inquire through this activity. It allows them to see that in Science 100% results are not always guaranteed and there needs to be a process of testing and retesting to be able come to conclusion about a specific hypothesis. One way the circuit may better work is with the use of pure zinc and copper electrodes.

The students are able to explore different ideas of what battery can comprise and this activity allows for the students to come up with other day to day items that can potentially be used as batteries. Batteries are very important in day to day life as we use them in cars, remote controls, flash lights, etc.

**Important Vocabulary:**

* Circuit: a path containing mobile charges.
* Electrolyte: a substance that contains free ions which allows it conduct electricity
* Electrode: an electrical conductor that is used to connect to electrolyte (non-metallic part) of a circuit
  + There are two types of electrodes in electrochemical cells
    - * 1. Anode (-) (Zinc)
      * 2. Cathode (+) (Copper)
      * Electrons move from anode to cathode
* Open circuit: a circuit that has a break that prevents the flow of current.
* Closed circuit: a circuit that has a complete path for charge to flow.
* Parallel circuit: a circuit that contains two or more branches.
* Series circuit: a circuit where moving charges can only follow a single path.
* Current: the flow of electrical charge.
  + In a metal wire, current is the flow of negatively charged particles (electrons).
  + In a battery, your body, or other wet places, current is the flow of both positive and negative charges.
  + When current flows through a closed circuit, charges flow in a complete loop through the wire and battery.
* Voltage: is electrical potential difference and is measured in joules (the potential difference between two points)

**Safety:**

There are no major safety concerns with this activity.

**Note:**

Instead of citric acid other electrolytes can also be used and students can see which materials are able to conduct electricity.

**Student Handout:**

**Introduction:** Batteries are very useful in world today and are used to power flashlights, computers, cars, etc. As Scientists, we are always looking for ways in which we can reduce carbon footprint and come up with innovations, ideas and inventions that allow us to come up with unique and environment friendly product. Today we are going to look at whether lemons can make a good battery or not.

**Materials:**

1. Four to five juicy lemons

2. Five galvanised nails or zinc washers

3. Five copper pieces (size of 10 cent piece)

4. Six wires

5. An LED

6. Volt meter

**Method:**

1. Make a slit into each lemon approximately 3-4 inch apart

2. In one slit push copper piece

3. In another slit push zinc nail or washer

(Make sure that copper and zinc pieces do not touch each other)

4. Make a series circuit using lemons by connecting each lemon with the wires provided

5. Attach the wire from copper piece of the lemon at one end to the long leg of the LED

6. Attach the wire from zinc piece of the lemon at the other end to the short leg of the LED

7. Observe and record results

**Observation Table:**

\* LED may not necessarily light up.

You can explain why in the discussion question.

|  |  |  |  |
| --- | --- | --- | --- |
| **No of lemons** | **Prediction ( LED Will light or not)** | **Voltage** | **LED\* lit up**  **(Yes/ No)** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |

**Discussion Questions:**

1. Did the observations match predictions when you were compared the different numbers of lemon? Why do you think the LED did or did not light up?

2. What was the voltage across the circuit and what does this mean in terms of electric current passing through the circuit?

3. Which metal is anode and which metal is cathode in this battery and which way is the flow of electrons?

4. In a battery electrolyte is made up of ion and helps make successful battery. What is the electrolyte in this battery?